Final Report for NOAA Office of Global Programs, Economics & Human Dimensions Program

Title: Effects of ENSO events on Peruvian Social Economics and Legal Systems

PI: Sarah Keene Meltzoff
Co-PIs: Daniel Suman, Kenneth Broad

Division of Marine Affairs and Policy, RSMAS, University of Miami
4600 Rickenbacker Cswy., Miami, FL 33149
305 412 4085

Time period: 1999-2001

Sarah Keene Meltzoff Segment:

October 2000-May 2002 Three ethnographic research fieldtrips.

Preliminary Materials

Abstract

Sustaining El Niño–Induced Scallop Booms with Aquaculture: **Livelihood Transitions of Artisanal Fishing People in the Paracas National Reserve, Peru**

Intense El Niño events bring fleeting bounty to certain export fisheries along the Pacific South American coast in the form of scallop abundance. This report explores human dimensions of climate variation, from fisheries' boomtimes and migration into Paracas National Reserve to aquaculture attempts at stabilizing coastal livelihood in between eagerly awaited events. It examines the ensuing political struggle over the development, control, and management of such aquaculture inside the reserve. Peruvians rush to Paracas National Reserve to harvest the thick banks of scallops that spring up as a result of major El Niño events. As an alternative to these opportunistic boomtime fisheries, artisanal fishermen of Paracas have been developing scallop aquaculture inside the reserve's rich marine ecosystem. By forming small associations, these artisanal fishermen have qualified for marine tenure within the clean rich waters of the reserve. In order to access the capital input, technology, and training necessary for aquaculture, artisanal associations work in partnership with a sole scallop exporter/processor, Bent Mogelberg with his company Alaska. Bent acts as a *padrino* figure for them. Local aquaculture partnerships with the exporter/processor rely on his technical support and capital. Both sides trust in-the-water evidence of a new natural plentitude, visual clouds of scallop larvae and high larval counts, not forecasts, before investing in new gear. However, given radical political swings at the national level over marine management, they must be equally concerned with lobbying efforts to regain access to their

concessions. The exporter/processor also is able to maintain crucial political lobbying to endure shifting government policies regarding aquaculture development and their marine concessions and conservation inside the reserve. Overall, I chart the struggle among multilevel stakeholder groups over policies regarding aquaculture development in the context of climate variation. Mapping these perspectives, I suggest more participatory ways to succeed in managed development.

Objective

Paracas peninsula juts out from central Peru's desert coast (see Figures 1 and 2) into the nutrient-rich Humbolt Current, one of the world's most fertile fishing grounds. Laguna Grande, a cove with settlements and the wharf, sits at the head of Bahia Independencia (BI) running southward. It is all a part of the Paracas National Reserve and rarely visited by anyone but fishing people. Offshore, natural banks of scallops thrive in near optimal settings. The only land routes skirt sand hills and jagged sea cliffs back up to Paracas. 80 percent of Peruvian scallop exports during the second boom were from BI, making the area an economic workhorse during such times
Since the first boom began in 1983–1984, Peruvians have been drawn to Paracas National Reserve to harvest the rich banks of scallops that spring up as a result of major *El Niño* warm-water events—climate variability. As an alternative to this opportunistic boomtime approach, artisanal fishing people began developing scallop aquaculture inside the reserve's rich marine ecosystem.

Three major themes underscore this ethnographic human dimensions research. The first theme is what drew me to the Paracas area as a field site: powerful El Niño events combined with federal funding opportunities to explore social change interacting with this major environmental variation.[1] It proved fascinating the manner in which different interest groups deal with high increases in natural resource productivity induced by El Niño.

Paracas, Peru, is beautifully situated at the crossroads of major currents causing rich upwellings that have created abundant and important fisheries since pre-Colombian times. The marine environment is periodically altered in dramatic ways during more radical Niño and Niña's alternatively warm- and cold-water events in the ocean. They cause profound but relatively temporary marine ecosystem changes. Nature holds the cards here when it comes to shifts in marine life abundance, far beyond human actions including harvesting and management.

Accomplishments

Fieldwork

I explored coastal social change and impermanence given climate variability and the shifting environmental, economic, and political atmospheres. I analyzed how

production of a commodity is shaped by these global and local processes. In this context, local partnerships are forced to negotiate radical swings at the national level for marine management. In this area extremely vulnerable to major ENSO events, I charted the struggle among multilevel stakeholder groups who wish to control policies regarding aquaculture development. Ultimately, I provide a look at possible unities and ways that aquaculture could be mutually beneficial as a way to stabilize livelihood in between major ENSO events.

Research Methodology

The research methodology is ethnography, doing participatory observation and carrying out in-depth life and work interviews. The type of ethnography is political ecology: mapping stakeholder groups, viewing the community as hierarchical, examining multi-political levels of interactions, and setting all within an historical perspective.

Understanding Paracas Stakeholder Groups in Light of ENSO

It is late May 2002. The national television and press media are discussing the possibilities of a full-blown Niño by 2003, while key Web sources continue to contradict themselves as usual. The Scripps' Internet site, the processor Alaska's favorite, is showing an enormous Niño on the horizon. Scripps has been consistent with Alaska's own experience, although Alaska still only acts when the visual indicators are in the water itself—such as larval clouds and flying crabs, and lab tests counting numbers of larvae in a water droplet. Bent who is Alaska personified, the associations, the NGO, and the biologists were all monitoring the water, looking for proof in the water, having faith based on this, not on modeling. Because labs of Alaska and the NGO perform water measurements in different locations (e.g., for oxygen, temperature, number of larvae, plankton) they often arrive at opposite conclusions as well. In the end, there was no general consensus about the coming of yet another major Niño event.

Bent cited Alaska's need for only a 90-day lead time to set up aquaculture equipment. He and others would not dare invest until the scallops become apparent in numbers. Moreover, with no recognizable accuracy of long-term forecasts, the various conflicting local and non-local reports become a wall of noise—useless as a means to guide fishing investment.

In accuracy of predictions in Paracas inhibits trust and use of climate forecasting in the ocean to date.

Most groups that did not have Bent pushing them to put gear in the water at this time sat on the sidelines with neither finances to put materials in the water nor confidence in the timing. The artisans were following their old practice of awaiting a boom. Though El Niño holds most of the cards for opportunistic booms, the fate of aquaculture in the Paracas National Reserve has as much to do with El Niño as it does with multilevel politics and the interactions between Paracas' various stakeholder groups—each with its

own individual agenda, area of influence, and subsequent pattern of reaction to El Niño predictions.

The type of aquaculture in Paracas, which depends on natural seed extraction instead of lab seed production, could not cause genetic erosion. WWF learned at this meeting how the BI scallop stock rejuvenates itself in natural cycles with the Niños and about how deeper natural banks thrive outside the reach of harvesters. Thus, aquaculture inside the reserve and around Paracas has the privilege offered by nature of utilizing an abundant source of wild seeds, making suspended-line aquaculture in BI's reserve waters a safe bet from the standpoint of genetic diversity.

It is also noteworthy that scallop aquaculture is totally distinct from harmful practices in shrimp aquaculture, which destroys mangrove forests and takes fish away from the community in order to feed the. Because scallops are filter feeders, they do not require fishmeal as food and therefore do not spoil the ecosystem. In addition, scallops are suspended on lines hanging from a floating frame so that no habitat is destroyed. If anything, scallop aquaculture, in which harvesting is done from the suspended line product, may actually help improve water quality and might help maintain banks continuously on the bottom. In 2001, a year of scant larval presence, an assessment of BI by the official biologists for the Ministry of Fisheries found the greatest coastal abundance of scallops to be located under one of the reserve's main areas for concessions, Tunga.

These banks will regenerate themselves in any case with annual summer Niño conditions. But especially during the intense and prolonged Niño years, scallops repopulate with a vengeance, making a terrific biological comeback over the entire bay and simultaneously fueling the local economy. Thus there is little risk of permanent harm to the marine reserve ecosystem through scallop harvesting as long as the deepest banks remain untouched by divers. With an added twist, opportunistic harvesting could actually help ensure against Niño-induced red tide conditions as thick, overpopulated banks decompose.

What would a third major event engender? While an intense El Niño brings disaster to many parts of the world in the form of flooding, hurricanes, and fishing/agricultural losses, it brings fleeting bounty to certain fisheries of the Pacific South American coast in the form of scallop abundance. The Paracas National Reserve, as presented in this report, serves as an excellent and easily understood case study through which to explore the underconsidered role of nature in political, social, and economic issues . Because there were some signs of a boom peaking in October 2002 and into 2003, concessions that had operated mostly by name only since the end of the last boom in 1999 reinstated guards to claim their tenure rights. They hoped to protect their suspended formal and informal contested rights to the scallops that might start settling out underneath their aquaculture line sites, even if they have no lines yet.

When a boom does ensue, it will once again become riotous in Paracas. Aquaculture might move to the back of people's minds, but marine tenure will remain

essential for associations. Artisanal aquaculture with marine tenure and adaptive management strategies are still untested. The fate of aquaculture and the role that climate variation plays in either the success or the downfall of political, social, and ecological harmony within the reserve will depend on the ability of its assorted stakeholders to unify competing visions into a collective dream.

Bullets of Results

- Poor accuracy to date of oceanic predictions in Paracas inhibits trust and use of climate forecasting for aquaculture development.

- Brusque political and economic shifts in Peru, as in many nations, promote short-term business planning and household decision-making. Climate is yet another variability that people feel motivates them to act on short-term plans. This short-term planning is a logical approach and practice for interest groups and individuals in economic, political, and environmental climates where tomorrow can likely turn everything upside down, including laws, currency valuation, job availability, and access to resources.

- Facing the uncertainty of El Niño, development of scallop aquaculture in BI, Paracas could be a strategy to improve the livelihood of the artisanal fishermen. Now, they must wonder how long before the next intense El Niño event triggers a wealth of scallops).

- Divers' knowledge of El Niño indicators in the water and of scallops seeding could serve as a foundation on which to build more technical knowledge pertaining to scallop aquaculture.

- If the Peruvian government were to invest in aquaculture infrastructure, like the Japanese for Mutsu Bay, they could stabilize aquaculture development and generate export earnings as well as stabilize local incomes and ensure that long-term investment would be relatively safe in between El Niño events.

Publications and Presentations

Sarah Keene Meltzoff, Michael Lemons, Lila Asfour, Gleyts Guardia-Montoya, and Ricardo Gonzales. Sustaining El Niño–Induced Scallop Booms with Aquaculture: Livelihood Transitions of Artisanal Fishing People in the Paracas National Reserve, Peru. Culture and Agriculture Journal. Spring 2005, Vol.27 (1), 1-15.

N.d. Sarah Keene Meltzoff. Transformation Along the Water's Edge: The Ethnography of Fishing and its Heros from Patagonia to Paracas. Book manuscript on the overlapping human/environment fieldwork from 1995-2001 funded by NOAA and NSF.

Panel presentation on Paracas Climate and Aquaculture development at the annual national meeting of the Society for Applied Anthropology in Portland, 2003.

Shift from Orginal Proposal

Meltzoff, Broad, and Suman found it productive to carry out separate research agendas from the beginning. We have divided up the original work agenda along the lines of our own capacities. This has led to our three parallel but different approaches, each with interesting results. Therefore, we are submitting these three individual segments for our final report to NOAA.

Meltzoff stretched her budget to extend her field time to cover a third research season, in order to witness interactions during the predictions coming in through Scripps of a potential of a third big ENSO event.

How the Project Dove-tailed with NSF and Other NOAA Funding for Ethnographic Fieldwork in Chile

The work builds on fieldwork opportunities provided by NSF and NOAA, whose munificent funding allowed Meltzoff to carry out comparative research along Chile's coast from 1995 through 2000.

Adaptation to Long-term Climate Change via Aquaculture

Almost nobody has been able and willing to take the economic and political risk in the face of climate variability and short-term political policies to develop scallop aquaculute in Paracas in between climate events that bring natural abundance and wealth. Only the key processor/middleman/padrino figure in Paracas could and did devote enormous amounts of energy to stabilize artisanal concessions legally through personal lobbying efforts. This man, Bent Mogelberg, through years spent in Latin America, understood political strategies and had high connections. He dreamed of stabilizing marginal artisanal livelihoods in the reserve outside natural boomtimes. Thus, when the artisanal concessions were politically threatened, Bent lobbied intensively from the admiralty to the government oligarchy in order to keep Paracas aquaculture alive. He knew that legal security harbors an essencial long-term business perspective, one that could sustain scallop harvesting outside climate events.

Development and Socioeconomic Impact of Climate Cariability

Triggered by ENSO climate events, rich scallop harvesting opportunities in Paracas create boomtimes in the area. These boomtimes create unstable, uncertain fat periods for fishermen. And, they create wild swings of migrants into the area and into the fisheries. This brings on hostilities among locals and the outsiders who are dubbed foreigners-- *foraneos*. Resource competition is fierce. And people risk their lives diving for the scallops. The destabilizing impact of the booms could be minimized by actually

granting participatory management that goes all the way in allocating concessions that guarantee marine tenure rights to associations of fishermen who are granted these concessions. Thus, these associations would guard their concession areas especially during booms.

Ways of Communicating Uncertain Information

In the case of Paracas scallop fisheries and aquaculture, ENSO climate predictions are still so uncertain that locals do not organize their production with this information. The processor and the NGO do read the predictions on at least 13 different web sites which offer contradictory interpretations. The processor partnerin aquaculture, like the fishermen themselves believe in the actual in-the-water conditions, especially seed counts, to start investing in gear and putting out collector nets.

This is not seen locally as an issue of communication, rather it is perceived of as a matter of forcasting not being to a point where it can predict duration,m intensity, on or off-shsore events, besides whether there will be a particularly strong event in a given year. And fishermen traditionally follow what they can see with their own eyes, regardless of accuracy of scientific predictions.

Future Research

Meltzoff is now carrying out fieldwork in Isabela, Galapagos on human/environmental aspects of fisheries in the far western port town of Villamil. This research builds on Meltzoff's work in Chile and Peru where participatory management models in fisheries are being developed in light of climate variability and other destabilizing factors, such as short-term political policies.

In Galapagos, the 1982-83 ENSO event wiped out coral communities and altered the underwater habitats now visited by sport divers. Dive tourism has become an economic driver in Galapagos with people wanting to see sharks, such as hammerheads. But sharks are rapidly diminishing due to illegal finning which is locally seen as a way to earn income now that other fisheries are overfished.

Meltzoff, again utilizing political ecology, is examining these gaps between local perceptions of community development and international conservancy norms. The current political debate is focused around seeking fisheries alternatives. However, these alternatives consist of legalizing what are seen by international conservationists as destructive methods, such as deep long-lining and fish attractors devices (FAD). The most hotly contested fishery, illegal shark finning, is not under discussion, although it provides income to the community. There is ardent internationalist pressure to transfer reliance from fishing income onto a projected social economy generated by tourism, including shark diving. Participatory management is at the heart of the debate.

Photos

See CD being mailed under separate cover.

Daniel Suman Segment:

Preliminary Materials

Project Abstract

Peru is one of the world's most important fishing nations, producing about 10 percent of the world's fish landings. About 93 percent of these landings are destined for reduction to fishmeal that sells for a relatively low price in global markets. The fishmeal industry depends almost exclusively on anchovy, although other small pelagic species are also used at times. Only 7 percent of landings are used for direct human consumption (canning, freezing, and other products). Both Peruvian industrial and artisanal fisheries are significant. The industrial fleet has at least 734 vessels. The artisanal sector is also large and counts 7,700 vessels and 55,000 artisanal fishers. Ample evidence suggests that in both fishing sectors, vessels and fishmeal plants are over-dimensioned for the available resource. Peruvian fisheries resources are also notable for their significant fluctuations in the availability of the resources with large-scale climate variability – El Niño – Southern Oscillation (ENSO). With ENSO changes in sea surface temperatures and the increase in the thermocline, anchovy resources tend to be less available, migrating to the south along the Peruvian coasts or submerging. ENSO impacts on Peruvian fisheries have been different for different events. In the 1972-73 ENSO event, the anchovy fishery collapsed; in the 1982-83 event, anchovy collapsed and sardines filled the niche; while in the most recent 1997-98 event, anchovy landings remained strong. During all three strong ENSO events, however, tropical species, such as tuna, shrimp, and scallops, migrated to the south into Peruvian waters. Similarly, all events caused damage to infrastructure (roads, bridges, and port facilities) and created difficulties for the export of fish to markets in urban areas.

In order to examine the ability of the Peruvian fisheries sectors to adapt to this resource variability, the research team conducted interdisciplinary field research with different sub-sectors of the Peruvian industrial and artisanal fisheries. The research indicated that the fishery sectors in Peru demonstrate a great ability to adapt to ENSO events – but that the adaptations could still be much more efficient and effective. The strategies of the industrial sectors are focused on economic survival and occur to a great extent independently of government regulation. Strategies include advocating the extension of the fishing seasons and areas, as well as replacement of the target species (anchovy) with substitute species that can also be reduced to fishmeal and fishoil. More recent strategies include diversification shifts to higher value products that are not as dependent on climatic variations. The fishing enterprises also adopt a number of operational strategies (movements of fishing fleets, adaptation of gear) and business strategies (personnel reduction, suspension of new investment, reduction of expenses) to face the scarcity in the prime resource. The artisanal sectors have much less ability to maneuver, thus their strategies are limited to changing gear and targeting newly available species. This sector enjoys minimal support from the government or financial institutions. In the 1990s, the financial sectors (banks and lending institutions) became increasingly sophisticated and adopted increasingly conservative lending positions. The

more sophisticated representatives incorporate ENSO predictions into their lending packages and increasingly reply on scientific information provided by government officials. Some of the more sophisticated banks have hired their own fishery analysts. Government regulatory institutions have also partially shifted their manner of reacting to ENSO events. Instead of relying entirely on global quotas, regulators are utilizing increasing flexible and adaptive strategies that attempt to be more specific and cause smaller adverse impacts on the fishing industries. This new fishing regulatory regime is only possible because of improved climate prediction data**.**

Objective of Research Project

The goals of this project were to 1) describe how ENSO environmental changes affect the fishery sectors and how these changes translate into larger societal changes, 2) analyze adaptive strategies of the Peruvian fishing sectors to ENSO and predictive climate models, and 3) identify constraints in the application of current probabilistic forecasts.

Approach

Work conducted by Suman included interviews and legal analyses. Interviews extended to the entire fishery sector, including industrial fishing organizations, industrial fishing enterprises and fishmeal plants, artisanal fishing confederations, academic fishery scientists, government fishery regulators, government fishery scientists, government economic analysts, and financial representatives of the major Peruvian banks and lending institutions. Legal analyses examined a decade of Peruvian statutes and regulations related to the fishery sectors to examine changing strategies and approaches to fisheries management.

Description of any matching funds used for this project.

Suman had no matching funds for this project.

Interactions

Interactions with decision-makers included:

1) government fishery scientists at the IMARPE (Peruvian Institute of the Sea) in the pelagic resources section, the aquaculture section, the artisanal fisheries section, the planning office, and the office of the Director.
2) officials at the Ministry of Fisheries in the offices of pelagic resources, artisanal fisheries, aquaculture, planning, environmental quality, and the general counsel
3) officials at the Institute for Fishery Technology that develops alternative fishery products and technologies
4) PROMPEX (Office of Promotion of Exports)
5) CONAMA (National Environmental Council)
6) Peruvian Society of Environmental Law

7) Several Peruvian NGOs
8) Four banks that are the principal lenders to the industrial fishing sector
9) 10 industrial fishing enterprises throughout the country (Lima, Piura/Paita, Paracas, and Chimbote)
10) the National Fisheries Society
11) the National Confederation of Artisanal Fishermen
12) university scientists from the National Agriculture University, the National University of Piura, the University of Piura, and the Federico Villarreal University

Description of interactions with climate forecasting community

Suman's portion of this project had no separate interaction with the climate forecasting community.

Coordination with other projects of the NOAA Climate and Societal Interactions Division

Suman's portion had no separate coordination with other projects of the NOAA Climate and Societal Interactions Division.

Accomplishments

This portion of the research project indicated the diversity of adaptive strategies of the Peruvian fishery sectors and, at the same time, their limitations. An important evolution in strategies occurred during and after the most recent major ENSO event (1997-98) – perhaps because of improved climate predictions that became available to the government scientists and regulators and the major industrial enterprises.

Industrial Fishing Sectors

One important theme of the project focused on adaptive strategies of the industrial fishing sector to ENSO events. This sector tends to be sophisticated and keenly aware of the possibility of the occurrence of an ENSO event with its potential impacts. Our interviews with fishery managers demonstrate that the industry itself adopts numerous adaptive strategies to ENSO climate variability that are often independent of the regulatory agencies. Industry attempts to prepare itself for another ENSO by developing a comfortable economic position.

Industry has developed a number of strategies to confront ENSO events. The first strategy is to demand that the government allow their vessels to continue fishing despite the impending climate event. This is the "Let us fish" strategy. "My business is fishing, and if I have to make my motor work with a piece of gum to continue fishing, I'll do it," commented one industrial administrator after the 1997-87 ENSO event. Similarly, another noted that "[a]nchovy moves to the South (Chile) and will die in warmer waters. If we can't fish anchovy, it will die or the Chileans will capture it."

A second strategy is to fish for replacement species for anchovy that also can be reduced to fishmeal and fishoil. A typical reaction in the 1997-98 event was "[i]f there is no anchovy, let us fish for sardine, jack mackerel (jurel), or caballa (Pacific Chub Mackerel) so that we can meet our fishmeal contract obligations."

With the first indication of a strong ENSO event, industrial decision-makers also attempt to stockpile fishmeal for months and wait for the price to increase. This strategy depends on their excess with respect to their contract obligations. Higher value products provide cushion against the unexpected economic downturn, and numerous enterprises are opting to change their lines of production to higher value products. For example, many fishmeal enterprises are keenly interested in producing fishmeal of higher quality and value (prime and superprime lines). Since 1990, 40 percent of fishmeal plants have switched technologies to produce specialized fishmeal lines. The expansion of salmon aquaculture in southern Chile guarantees a market for Peruvian prime fishmeal. In addition, other enterprises are beginning to diversify from production of fishmeal to products for "direct human consumption". The new product lines require vessels with refrigerated seawater (RSW) that can land a higher quality product. In Peru, these diversification strategies are in their initial stages of implementation.

A few firms have begun to invest their profits in other economic sectors, such as aquaculture, real estate, and mining that are not subject to the vagaries of fisheries. However, unlike the Chilean case, diversification of the business investment portfolio is not common yet in Peru. Consolidation of business is also on the horizon. Four industrial groups currently produce 60 percent of fishmeal in Peru. Approximately 70 fishing companies are in bankruptcy and are formerly under government intervention by INDECOPI. The largest, most efficient, most flexible and diversified companies have begun to take over the assets of the weaker businesses, and this consolidation will be more and more common in the future.

Industrial fishing firms also adopt a number of operational strategies to address the changes in resource availability during ENSO events. Fleet managers spatially move their fleets to continue fishing for anchovy. Companies have an operational advantage if they have multiple plants strategically placed along the coast, fishing permits for multiple species of fish, and new or upgraded vessels with refrigeration. Fishing enterprises also modify their nets to fish for alternative species, increase the use of satellite information (chlorophyll and temperature) to locate fish stocks, and enhance operational efficiency through a) reduction of expenses, b) suspension of new investments, c) reduction of maintenance operations, and d) reduction of personnel.

The Artisanal Sector

The artisanal sector is, of course, much less sophisticated and able to access climate information and forecasts. Nevertheless, this important fishing sector also displays a number of adaptive strategies in the face of ENSO climate events. The 1997-98 ENSO resulted in an increase in availability of tuna, flounder (lenguado), eel

(congrio), bonito, scallops, and giant squid (pota) in nearshore waters. Adaptive strategies of the artisanal sector included changing gear and targeting newly available species. Over the years, the State has displayed little interest in providing assistance to artisanal fishers. This fishing sector rarely satisfies the requirements for government credit from FONDEPES (National Fishery Fund).

Additionally, ENSO events enhance the conflicts between the artisanal and industrial sectors over fishing space. Although the artisanal sector has gained a Five Mile Artisanal Fishing Zone adjacent to coastal lands, industrial fishing vessels often do not respect this artisanal fishing zone. Moreover, in 2001 the Ministry of Fisheries attempted to open the Artisanal Zone in southern Peru so that industrial vessels could conduct "exploratory fishing".

The Banking Sector

The Peruvian banking sectors display an evolution in their responses to ENSO events that is evident by their reaction to the most recent event in 1997-98. Prior to the 1997-98 ENSO, the banking sector operated with total ignorance about the fishery sector. The extreme informality of their operations was responsible for a large numbers of high risk loans to the industrial sectors. The most recent ENSO in 1997-98 caused a severe crisis for the fishery sector due to the fall in prices of fishmeal and a sectoral debt of USD $2,000 million. As a result of the difficult financial situation, the banking sector has adopted a different approach to the fishery sectors during the post-ENSO period. Banks have called for restructuring and refinancing of the fishing enterprises, as well as debt reduction (3 to 7 years to re-capitalize). The larger banks have adopted policies of strong oversight of fishing businesses and, generally, a much more conservative lending attitude. Today, Peruvian banks refuse to lend to investment requests that could increase the fishing fleet and fishmeal plants. The more sophisticated banks integrate ENSO probabilities into payment plans and exhibit an increased confidence in IMARPE (Peruvian Institute of the Sea) and the climate forecasting that the institute makes available to the sector.

Government Regulations

In Peru, the Ministry of Fisheries regulates and enforces industrial and artisanal fisheries while the Peruvian Institute of the Sea (IMARPE) conducts the research and monitoring necessary to provide the Ministry with the facts necessary to develop regulations.

Prior to the 1997-98 ENSO event, the Ministry of Fisheries managed pelagic anchovy stocks with a single regulatory tool: global anchovy quotas. Fisheries scientists in IMARPE began to consider that this simplistic regulatory tool was inefficient, inflexible, and subject to great scientific uncertainty. During this most recent ENSO and in subsequent years until 2001, IMARPE scientists and the Ministry of Fisheries adopted a new type of precautionary management of pelagic species. This comprehensive management strategy was called the Provisional Fishing Regime. Its characteristics

included: no use of quotas, management on a short time frame, and flexibility and adaptive management. These short-term decisions also required increased oceanographic and fishery observations. The Provisional Fishing Regime also continued after 2001 due to high incidence of juveniles in the pelagic stock. These management strategies include a high degree of flexibility that favors the industry sector through the use of exploratory fishing and provisional fishing – even when the fishery is "closed".

During the most recent ENSO event, the Ministry of Fisheries also demonstrated great flexibility in granting permits to fish other species that display increased abundance so that the fishing fleet and fish processing plants would remain as active as possible.

The most recent variability in the availability of pelagic species also provided incentive to open the discussion in the fishing industry and among regulators regarding fleet reduction, over-dimension of the fleet and plants, and the potential adoption of Individual Transferable Quotas (ITQs). Opposition to these concepts from fishing industry and the group that represents it, the National Fishery Society, was strong.

One would expect that Peru's high dependence on pelagic species used to produce low-grade fishmeal, as well as the swings in the stock availability due to ENSO events, would encourage the government agencies to diversify production and move toward a suite of higher value products. Nevertheless, the government agencies displayed only weak attempts to diversify production lines (Institute for Fishery Technology) and increase exports of alternative products (Prompex).

The Use of Climate Predictions and Forecasts in Peru

Our interviews indicate that the providers of climate information to the Peruvian fishing sectors included Peruvian governmental agencies, Peruvian universities, individual Peruvian scientists, IRI, NOAA, NASA, and WMO. The information that the providers disseminate included: a) real time data of environmental parameters (SST, winds, and thermocline depth), b) computer-generated forecasts of sea surface conditions, precipitation, and temperature anomalies, c) indices of ENSO phases (Southern Oscillation Index, Multivariate ENSO Index), d) experimental forecasts of environmental variables produced for research purposes, e) qualitative statements characterizing ENSO evolution, and f) qualitative and quantitative projections of the effect of ENSO on biological and economic parameters.

Constraints on the Use of Climate Predictions

Numerous scientific and societal constraints exist on the effective use of these climate predictions. Forecasts in themselves contain numerous limitations. Forecasts contain probabilistic information, but users are often not capable of understanding the uncertainty involved or the meanings of probability distributions. Additionally, no two ENSO events have similar effects, so preparations based on past events may not always be possible. Most importantly, great uncertainty exists regarding the links between climate, ecosystem, and fisheries stocks.

Societal limitations are perhaps even more significant that the scientific informational limitations. The consequences of climate forecast information depend of the social context. The simplistic goal of "societal benefit" is too broad and diffuse, as well as being highly simplistic. Access to and use of information by different societal sectors result in winners and losers. Moreover, the strategies that groups with information adopt for dissemination affect who receives the information and who does not.

Other societal limitations include the culture of secrecy; institutional competition results in a tendency to withhold the best information. Additionally, the media often tends to adopt a sensationalist tone with respect to ENSO predictions and be responsible for dissemination of misinformation. During ENSO events, like the most recent one in 1997-98, the public is bombarded with excess and often contradictory information from numerous sources. The result is that the public does not know what information has greater veracity.

Adaptive strategies of the fishery sectors also offer numerous limitations. Alternatives to fishing the normal target species, as well as alternatives to fishing in general, are difficult to enact within a reasonable time because of industrial inertia and uncoordinated political and environmental timescales. The different perceptions of ecosystem resilience limit collective actions. The traditional inertia of the fishing sector limits the ability of the sector to take advantage of information. Moreover, some responses and adaptations of the fishery sectors may be negative and unintended: increased fishing effort and overfishing, conflicts among users, oversupply and absence of developed markets for newly available species, and reduced availability of credit. The weak enforcement capabilities of Peruvian authorities limits the effectiveness of the actions that the regulators can adopt and implement.

Kenneth Broad Segment:

Approach

Work conducted by Broad included interviews, participant observation, focus groups and household surveys. Specifics on the methods are included in the publications cited in this report.

Description of any matching funds used for this project.

IRI provided matching funds in the form of salary support, computer equipment and travel expenses for Broad.

Interactions

Description of interactions with decision-makers.

Extensive interaction between researchers at IMARPE (govt. fisheries institute), SENAHMI (govt. meteorological institute, and Instituto del Estudios Peruanos (IEP) occurred in various forms, including collaboration on survey and focus groups, training on climate and ecological modeling (organized by IRI and funded by World Bank) and involvement with a climate and fisheries workshop in Noumea, New Caledonia (see cited refs).

Description of interactions with climate forecasting community.

IRI was heavily involved with the support of the social science aspects of this work through matching funds as described above and through training efforts.

Coordination with other projects of the NOAA Climate and Societal

Interactions
N/A

Accomplishments

Ethnographic, survey and archival work conducted in Peru, funded primarily by NOAA OGP[i], resulted in theoretical and applied findings related to the dissemination of climate information. The first dimension involves issues related to aggregate versus distributive benefits that may result from provision of forecast information. Empirical observations during the 1997-98 event provided evidence that there was significant inequality in access, understanding and subsequent potential to use climate information within the fishing sector. This inequality was exacerbated by purposeful distortion of information for political and personal gain. The general theoretical point is laid out in the following publication: Pfaff, A., K. Broad, and M.G. Glantz, 1999. Who benefits from Climate Forecasts? *Nature,* 397:645-646. A more detailed case approach that goes a further step toward policy relevance of our findings argues that those groups

disseminating information are de facto making choices that have societal and ecological consequences. We argue that explicitly recognizing the tradeoffs in dissemination strategies will increase efficiency in achieving benefits, once those benefits are explicitly defined. We provide a conceptual model of this point using observations from the Peruvian case. This work is contained in: Broad, K., A.P. Pfaff, and M.H. Glantz. 2002. Effective & Equitable Dissemination of Seasonal-to-Interannual Climate Forecasts: Policy Implications from the Peruvian fishery during El Niño 1997-98. *Climatic Change* 54(4):415-438.

A second dimension to our work involved assessing the use of information to reduce vulnerability to climate variability. Again we focused on the fishing sector, but taking a more inductive approach we established linkages between impacts on fishing-based households to non-fishing related impacts (e.g., effects of climate on transportation sector, health, etc.). These finding, based on household level data, have direct implications for timing and target audiences for forecast dissemination. These results are presented in: Orlove, B., K. Broad and A. Petty. 2004. Factors that Influence the Use of Climate Forecasts: Evidence from the 1997-98 El Niño Event in Peru. *Bulletin of the American Meteorological Society* 85(11), pp. 1735–1743. Policy measures that influenced the use of information are documented in: Velasco-Zapata, A., and K. Broad. 2001. Peru country case study: Impacts and responses to the 1997-98 El Niño event. In Once burned, twice shy? Lessons learned from the 1997-98 El Niño, edited by Michael H. Glantz, Tokyo: United Nations University Press, pp. 186-199.

A third dimension of the work focused on our understanding of the ecological drivers in response to climate variability on different timescales. In particular, we looked at how ecological information was used in policy decision-making. This work involved ecosystem modeling and evaluation of satellite information and is described in: Carr, M. E., and K. Broad, 2000. Satellites, society, and the Peruvian fisheries during the 1997-98 El Niño, in Satellites, Oceanography and Society, edited by D. Halpern (ed.). *New York: Elsevier Science*, B.V. 171-191. An alternative theory to the role of ENSO in affecting predation (actually, we argue that without ENSO warm events the Peruvian anchoveta would never reach such highly productive levels) is put forth in: Bakun, A. and K. Broad. 2003. Environmental 'loopholes' and fish population dynamics: comparative pattern recognition with focus on El Niño effects in the Pacific. *Fisheries Oceanography*, 12(4/5):458-473. Many of the ideas that were inspired by the Peruvian research influenced a workshop sponsored by IRI and IPRC (with some NOAA and other funding sources). This workshop focused on gathering expert opinions on the influence of climate variability on multiple timescales, as well as regime shifts, on the marine ecosystem. Policy implications of the current state of knowledge were then considered. The results of this work can be found in: Bakun, A. and K. Broad (Editors). 2002. Climate and Fisheries: Interacting Scales, Paradigms and Policy Approaches. New York: Columbia Earth Institute and International Research Institute for Climate Prediction, IRI Publication-IRI-CW/02/1, 70pp. A general description of the biological and social dimensions related to ENSO impact on the Peruvian fishery is contained in: Broad, K. 2003. Biological and Societal Impacts of Climate Variability: An example from Peruvian Fisheries. In Handbook of Weather, Climate and Water: Atmospheric Chemistry,

Hydrology, and Societal Impacts. Edited by T. Potter and B. Coleman. *New York: John Wiley & Sons*, pp. 817-832.

The fourth dimension of the work addressed cultural factors that mediated the use of climate information during the 1997-98 event. One publication currently under review argues that current theoretical emphasis on the dominating forces of globalization neglects to account for the strong role of both the State in controlling resources and information as well as the national level cultural traits that influence receptivity and interpretation of information. In particular we explore the role of identity, imagery and national politics in shaping responses to the 1997-98 ENSO (Broad, K. and B. Orlove. Images, Identity and Politics: Globalization and the 1997-98 El Niño Event in Peru. *American Ethnologist.* Vol. pp. (under review)). Another publication compares the Peruvian case with another intensively studied case, that of NE Brazil, drawing some generalizable lessons: Pulwarty, R., K. Broad, and T. Finan. 2004. Science, Vulnerability and the search for equity: El Nino events, forecasts and decision-making in Peru and Brazil, in Vulnerability: Disasters, Development and People. Edited by G. Bankoff, G. Frerks and D. Hilhorst. London: Earthscan Publications, pp. 83-98. Finally, in another publication we argue for the need and opportunities to include more anthropological approach in the study of climate issues: Broad, K., 2000. El Niño and the Anthropological Opportunity. *Practicing Anthropology,* 22, No. 4:20-23.

[i] Additional funding was provided by IRI, NSF, The Tinker Foundation and the Research Institute for the Study of Man.